

No. 6. Vol. IX.

June, 1916.



10/6 Yearly.

THE JOURNAL OF SCIENTIFIC
ILLUMINATION.

1/- a Copy.

OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London 1909.)

SCIENCE AND INDUSTRY.

This number contains the *discussion* on
**"The Sphere of the Scientific and
Technical Press in relation to
Technical Education and Industrial
Research,"** at the meetings of the Circle of
Scientific and Technical and Trade Journalists
on March 14th and May 16th.

Other Articles include:—

REVIEWS OF BOOKS—CONCEALED CHURCH LIGHTING—
A SAFE LAMPGUARD, &c.

ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD.,
32, VICTORIA STREET, LONDON, S.W.
(TEL. NO. VICTORIA 5215.)

THE GAS LIGHT AND COKE COMPANY

will be happy at any time to co-operate fully with any Member of the Illuminating Engineering Society in the planning of the lighting of any room or building situated within their area of supply, and in making any experiments in connection therewith to the end of ensuring its illumination on scientific and practical lines.

Communications addressed to the Chief Office, Horseferry Road, Westminster, S.W., and mentioning "*The Illuminating Engineer*," will receive special attention.



THE JOURNAL OF SCIENTIFIC
ILLUMINATION.

OFFICIAL ORGAN OF THE

Illuminating Engineering Society.

(Founded in London, 1909.)

ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD.

32, VICTORIA STREET, LONDON S.W.

Tel. No. 5215 Victoria.

EDITORIAL.

The Technical Press and Economy in Lighting.

We have recently had occasion to mention the important public services to be rendered by the scientific and technical press in disseminating knowledge of scientific value and stimulating interest in industrial research. In the present issue we complete the discussion on this important subject, which took place at recent meetings of the Circle of Scientific, Technical, and Trade Journalists on March 14th, and again on May 16th.

We believe that there is a great field for co-operation between the Press, the chief scientific institutions and the State in bringing new ideas before the public, and guiding opinion in the right direction.

A good opportunity for the exercise of such educational effort is afforded by the urgent need for judicious economy in the use of fuel, emphasised in a recent circular from the Board of Trade, to which we referred in our last issue (p. 182). We also appreciate the urgency of the problem. But it is now fully recognised that proper illumination is an absolute necessity in daily life. The adequate lighting of an office or factory is as essential to the carrying on of work as the tools and materials employed. In support of this view we need only quote from the recently issued Report of the Departmental (Home Office) Committee on Lighting in Factories and Workshops, wherein it is acknowledged that defective lighting leads to spoiled work and diminution of output, and is a contributory cause of accidents and ill-health. This view has also received the support in the

Bulletin on the Lighting and Ventilation of Factories, issued by the Committee of the Ministry of Munitions on the Health of Munition Workers. In our streets and in our homes adequate illumination is likewise necessary in the interests of health.

It appears to us, therefore, that in striving for economies in lighting we should aim, not at an indiscriminate reduction, which might defeat its own purpose by causing drawbacks which outweigh the actual economy in fuel, but at *the exercise of greater care in the use of light*. Light which does not fulfil its object—which dazzles the eyes of workers instead of illuminating the material on which they are engaged—is undeniably wasted, and this waste should be checked. In our experience substantial economies have often been made by introducing the most efficient forms of lamps, and adopting scientifically designed reflectors which direct the light where it is needed. Glassware for this purpose is made in England in large quantities, and its use should also be extended on the national ground of encouraging home industries. It is the duty of the illuminating engineer to promote economies by these methods; and if Government Departments can bring their influence to bear in inducing people to adopt more scientific methods of lighting, they would not only achieve a much-needed present economy, but do valuable work for the future.

Apart from the opportunities for such economy in the interior lighting of buildings, we see around us many instances of waste of light, even in our dimly-lighted streets. For example, we see powerful street lamps, consuming a considerable current, but obscured so heavily that only a fraction of their light escapes into the street. In several districts we understand that considerable economies have been made by substituting for arc lamps suitable incandescent lamps of much smaller consumption in appropriate reflectors. Again, in many shops we see numbers of lamps, the light from which has been almost completely blocked by shrouding them with coloured paper or by covering the bulbs with obscuring lacquer. Fewer lamps of smaller consumption, equipped with properly designed screens, would serve the purpose much better.

These are a few instances of the waste of artificial light, and it may be recalled that a fuller use of daylight may also lead to economies. In the case of buildings with unduly small window area, or obstructed by neighbouring obstacles, the untimely diminution of daylight leads to artificial light being employed at a needlessly early period. In many such cases by making use of mirrors, or panes of suitable diffusing glass, the period during which daylight can be used may be lengthened, and the time during which artificial light is necessary restricted.

To put the matter in a nutshell, we venture to suggest that in further circulars the Board of Trade might well lay stress on the forms of economy mentioned above, inviting the co-operation of the technical press in order to bring about the needed saving in fuel. Many different aspects of the subject will occur in connection with various trades and technical journalists who are conversant with such industries, could doubtless often make suggestions in their columns which would tend in the desired direction. We feel sure that the importance of the matter would be readily appreciated if conveyed in this form; and members of the Illuminating Engineering Society, who have from the very first aimed at the suppression of waste of light on general grounds, would doubtless be only too glad to co-operate in such a campaign.

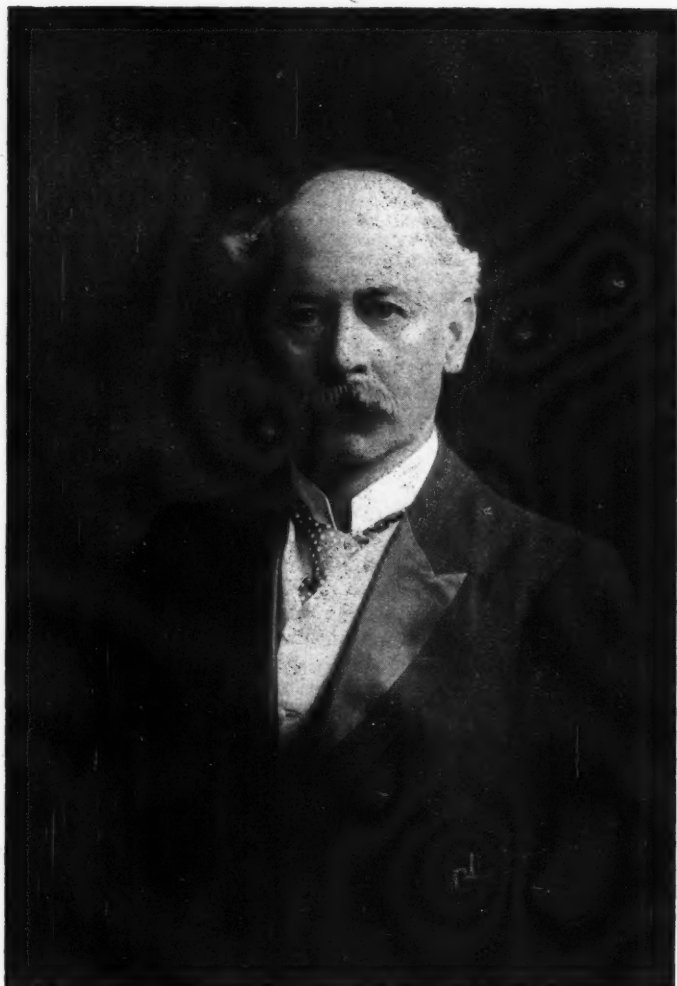


Photo. Lafayette.

Professor Silvanus P. Thompson.

BORN, JUNE 19th, 1851.

DIED, JUNE 12th, 1916.

It is with deep sorrow that we record the loss of Professor Silvanus P. Thompson, First President of the Illuminating Engineering Society, who passed away after a brief illness on Monday, June 12th.

His unexpected death came as a painful shock to the world of science not only on account of its suddenness, but because of the many close personal associations to which his singularly lovable and kindly disposition and his versatile gifts gave rise. Up to the very last he pursued his usual active interest in scientific work. On the Friday before his death he attended

Dr. Clarke's lecture on eyesight before the Royal Institution. Only a few weeks ago, in presiding at the Annual Meeting of the Illuminating Engineering Society, he spoke with all his accustomed charm and idealism, encouraging us by pointing out how many of the aims and objects of the Society—so admirably expressed in his own Inaugural Address in 1909—were gradually being carried into effect. We cannot do better than quote from what we now feel to have been a farewell message:—

"The whole function of the Society is to produce good lighting by whatever means, and the fact that Departmental Committees and officials of the Home Office are now persuaded, and more than persuaded, that this is a step to be fostered governmentally, is a complete justification for the existence of the Society. This, however, does not justify us in folding our arms and saying that our work is done, but it is an encouragement to go on in the future in the same direction and improve lighting of all kinds for the benefit of the community."

In Professor Thompson there were united rare intellectual gifts that gained for him a European reputation, and personal qualities that won the esteem and love of all with whom he came in contact. Throughout his active career he was almost equally eminent in engineering work and in pure science.

Optical problems had a special fascination for him, and his lectures before the Royal Institution on "Light, Visible and Invisible," were afterwards collected in a book that became very widely known. He filled the Presidential Chair of the Institution of Electrical Engineers, and the Physical, Optical, Röntgen and Illuminating Engineering Societies. In many cases he was among the first to give his support and encouragement to new institutions. The Illuminating Engineering Society, at least, owes him a debt of gratitude which can never be repaid.

With his wide, technical, and scientific knowledge he combined remarkable literary powers, a taste for antiquarian research, and practical ability as an artist and a musician. As an expositor of scientific subjects he was unrivalled. His books are models of lucid explanation, and he had, in a very marked degree, the power of interesting students and inspiring them with his own enthusiasm. His quick mind, tact, and *savoir faire* made him an ideal Chairman. His deep knowledge was adorned by a graceful gaiety and lightness of touch that gained the hearts of his audience.

These same qualities stood him in good stead at international gatherings, where he formed many close friendships. He spoke several European languages fluently. The writer has a vivid recollection of his graceful, address in Italian, delivered at a dinner given to Professor Pacinnotti, on the occasion of the International Electrical Congress, held in Turin in 1911.

In the Illuminating Engineering Society he endeared himself by his conscientious execution of his duties as President, and the admirable way in which he smoothed away conflicting interests—always cheerful and optimistic, with a generous recognition of the services of others, and a kind thought for all with whom he came in contact. He seemed by instinct to know the right thing to do and say on each occasion, and it was in no small measure, owing to his influence in the early stages, that the Council Meetings of the Society have, from the very beginning, been carried on in such an amicable and friendly manner. In his personal dealings with Professor Thompson the writer cannot recollect ever hearing him say a harsh word of any one. If he could not praise he would not blame. Truly he was a man such as one meets but seldom; and his loss, difficult as yet to realise, leaves a gap in the ranks of science which it will be hard indeed to fill.

LEON GASTER.

THE SPHERE OF THE SCIENTIFIC AND TECHNICAL PRESS IN RELATION TO TECHNICAL EDUCATION AND RESEARCH.

BY A. P. M. FLEMING.

(Introduction to a discussion at a meeting of the Circle of Scientific, Technical and Trade Journalists held at the Hall of the Institute of Journalists, Tudor Street, Blackfriars, London, at 8 p.m., on Tuesday, March 14th, 1916.)

(Continued from p. 166, May 1916, Vol. IX.)

General.

The fundamental requirement in manufacturing is to produce marketable commodities in the most economic manner. To accomplish this in the face of international competition necessitates turning to account every possible asset. Two of the greatest of these are industrial education and scientific research. Their value at present is not fully recognised.

To appreciate how the press can co-operate in making their importance appreciated requires first of all a clear grasp of the fundamental principles on which these two factors depend, and a knowledge of the specific obstacles that at present hinder progress.

Education.

While agreeing in general with Dr. Garnett's suggestion as to the need for specific education to suit all grades of industrial employment, for my present purpose it will be sufficient to group these grades into two classes, namely, *manual* and *non-manual* workers.

For the latter, which comprises the higher ranks of employment, there are already some facilities, although these are inadequate. For the former, suitable education, in an industrial sense, is woefully neglected. I will confine my remarks on educational matters to this class.

The greater part of juvenile labour representing the future skilled workers in industry is at present a wasted national asset, since due to lack of suitable practical training, and especially of education co-ordinating with daily work, its capacity for production is very far from being developed to its utmost.

While much may be done by the careful selection of youths and some bias given to their general education which will fit them for entry into industrial life, it is of the utmost importance that a continuation education of a character applying specifically to their work be provided. It is not sufficiently realised that almost every youth in industry who commences as a manual worker will continue as such all his life, and while there are many opportunities for him to acquire education fitting him for higher positions, this is to a large extent thrown away on the youth who will remain a manual worker. The kind of education I have in mind is that which can best be applied actually in works, but which under modern conditions of industry cannot be imparted to a youth under ordinary conditions during his practical training. A few progressive firms have instituted works schools for this purpose, and in this direction either individually or collectively employers can solve the problem. The fundamental difficulty is that employers in the main do not realise to what extent the value of a worker can be improved by suitable training and education, or to what extent such an improved worker is an asset in facilitating economic production. Much good would result from the education of employers through the various technical and trade press in the different industries to a greater appreciation, not only of their responsibilities in connection with the education of the juvenile worker, but to a realisation of the asset he may become. Thus far the employer has been passive in the matter, and has looked to the educationist to deal with the problem. Its

real solution can only come from the employer deciding what in his own interests is the best kind of industrial education his juvenile employees can have, and then making his voice heard in demanding that this kind of education be provided. Incidentally it should be noted that the development of a good workman is the best foundation on which education for citizenship can be based. It should further be noted that while some guidance can be obtained from the careful study of the methods adopted in other industrial countries, the whole problem is a psychological one which we have to solve to suit the characteristics and conditions of our own people.

Industrial Research.

Industrial research is spoken about so much nowadays that by some it is likely to be considered a sort of panacea for all industrial ills and its real function lost sight of. At the best industrial research can be considered only as a very desirable weapon—which manufacturers in this country have on the whole heretofore failed to make use of in their efforts to produce economically—and a means of providing new discoveries of science having application in industry.

The fundamental principle on which industrial research rests is that no industry can make progress without the continual addition of new knowledge. In earlier days this new knowledge was provided by the growing experience of the individual workers. This, together with results of the efforts of occasional inventors, ultimately became the common property of the industry. With the increasing complexity of industry and more exacting competitive conditions, this new knowledge became increasingly difficult to provide until far seeing capitalists appreciated the need for organising means and using every facility that science affords to provide a continual influx of knowledge. These men at the same time appreciated that sooner or later every scientific discovery finds its use in industry. It is along such lines that modern industrial research has developed, and its use in this country is necessary because it depends on this fundamental principle, and not merely because other countries have already

taken advantage of the facilities it affords. While this is so, some guidance can be obtained from the progress our competitors have made. In Germany, for instance, the important feature arising from industrial research has been the great appreciation shown by manufacturers of the benefits to be obtained from the application of science, and the absorption into their industries of very large numbers of highly trained technical men. Particularly have the benefits of industrial research been seen in the chemical and electrical industries.

In the States an enormous amount of industrial research has been carried out by individual firms. Striking results may be noted in connection with the research work done by the General Electric Co. dealing with improvements in electrical apparatus; in the production of chemicals, and in the initiation of several new factories for the purpose of manufacturing products discovered in the research laboratory. In the National Electric Lamp Association Laboratory, Cleveland, a great deal of the modern developments of electric lamps has taken place, and in addition in the pure science laboratory there, pioneer work is continually being done in the science of illumination. The American Rolling Mill Co., one of the largest producers of sheet steel in the States, owes its important speciality—the production of rustless sheet iron—to the research laboratory. The Eastman Kodak Co. maintains its position in the front rank as a producer of photographic chemicals and apparatus largely as a result of the pioneer work carried on in its research department under Dr. Mees. The recent success in long distance wireless telephony has been achieved largely as a result of the investigations in the research laboratory of the Western Telegraphic Co. A new industry for the manufacture of commodities from synthetic resins had its inception in the scientific work of the General Bakelite Co. In other directions in the States great progress has been made through the investigational work of such companies as the Dupont Powder Co., General Chemical Co., United States Steel Corporation, &c., in fact at the present time there are many corporations having research laboratories, costing

annually from £20,000 to £100,000 each for maintenance.

Apart from manufacturing concerns, important research work in connection with industry has been done by the Bureau of Standards, notably in connection with refrigerating machinery manufacture, and by such institutions as the Mellon Institute of Industrial Research, Pittsburg. In this latter institute—the work of which has been described on a number of occasions in the press—valuable industrial research dealing with glass production, smoke prevention, copper leeching, timber preservation, cement manufacture, paper products, &c., in many cases resulting in the commencement of new factories and in fact of new industries, has been carried out. Some of the most striking features of the research work in America are the lavish manner in which the laboratories have been planned and which in many cases enable large scale manufacturing operations to be carried out in order to determine the best possible methods of manufacturing any commodity developed or discovered in the laboratory; the appreciation of men of higher scientific training by industry, resulting in increasing numbers of students proceeding to their doctors degree before leaving the university; the increasing attention given in the research laboratories to pure science investigations, this being in my opinion the most important phase of industrial research; the absorption of men who have proven their capacity for industrial research in such places as the Mellon Institute, the Bureau of Standards, &c., by the various industries in which they have taken scientific interest.

In England our scientists have excelled in almost every field of pure science. In many isolated cases the discoveries thus made have been turned to account in industry. A notable example is that of the work of Sir R. Hadfield in connection with the production among other specialities of high grade magnetic quality sheet steel. Then again the whole of the electrical industry practically depends on the initial pure science investigations of the early electrical scientists.

From a national point of view, in order to utilise to the full the benefits of industrial research, it is necessary to organise

these scattered individual efforts so as to present an organised front instead of operating as a number of units. As to the lines on which this can be done, there are many alternative possibilities, and personally I am of the opinion that our efforts should be concentrated in one central institution comprising laboratories, each of which serves as the focus for one of the principal industries, rather than utilise a number of scattered institutions. It is immaterial at the moment, however, what plan is followed, as long as it is devised according to sound fundamental principles and that existing facilities be modified to fit in with an ideal plan rather than the plan being modified to suit existing facilities.

Obstacles in the way of National Industrial Research.

No progress can be made in the way of instituting a national scheme of research without a great deal of preparatory spadework. The greatest obstacle that at present exists is the lack of appreciation by manufacturers of the application of science in industry, and the general tendency to avoid the employment of the scientifically trained men. To a considerable extent this attitude reflects the lack of the real fundamental knowledge of science that should have been acquired in early education, and also to a complacency arising from the fact that the British manufacturer appears to possess to a greater extent than his international competitors, a capacity for industrial organisation which in the past has been a most important asset.

Co-operation of the Press.

It is in the direction of educating the manufacturer to a proper sense of the value of industrial research that the press can do most valuable work, in fact it appears to be the only method by which the lethargy of the manufacturer can be dispelled. To accomplish this educational work, however, it is necessary that a definite propaganda be planned rather than a species of sniping carried out at occasional intervals. It would appear to me to be desirable that the press should be organised so that in each industry the principal organs can devote consistently space for the purpose, first of all

of laying down the fundamental principles of industrial research; its economic importance as a weapon in meeting foreign competition, and by the adoption of new scientific discoveries outstripping competition; evidence of what foreign competitors are doing and the advantages they are achieving from research; examples of industrial research in this country and the general progress made by the more progressive firms in this respect. Through the principal trade organs the interest of the leading men in each industry could probably be enlisted to co-operate in this educational movement, and some good may result from the encouragement of correspondence on the matter in order to secure the view points of the people in industry.

Progress can only be made through the manufacturer being awakened to a realisation of the benefits that research can confer.

Quite apart from arousing some immediate interest in this subject, it is necessary to build far deeper and encourage increasing numbers of young men to secure sound scientific training with a view to entering industry. Particularly does this apply to those who will eventually inherit or occupy positions of importance in manufacture. Further, every effort should be made to divert into productive vocations those young men of ability who otherwise tend to pursue callings that have no productive value.

In planning an educational propaganda for manufacturers this might be facilitated and some scheme of working laid down by a conference between a few of the more progressive industrial people and representatives of the press. Ultimately it is likely, I should think, that separate organs for industrial education and research would be needed.

DISCUSSION.

In opening the discussion the CHAIRMAN mentioned that a telegram had been received from Mr. Hill, of the Scientific Organisation Association, regretting his inability to attend. Several prominent men of science had likewise sent letters expressing their interest in the meeting and regretting their absence owing to other pressing engagements.

Prof. R. A. GREGORY (*Nature*), who represented the British Science Guild, said that it seemed to have been forgotten or put aside for the time being that there is a difference between scientific investigation as generally understood, and industrial research. Usually the manufacturer, if he saw a way of making money out of the solution of a problem, would try to do something; that was industrial research, namely, research with practical profit in view. It was industrial research that made Edison send investigators all over the world to try to find a suitable filament for the first incandescent lamp. On the other hand, scientific investigation, which comprised all the best work that had been done, and had promoted the greatest development in engineering of all kinds and con-

ferred the greatest benefits upon the human race, was done without any consideration of profit whatever. That was the distinction between the two. It was scientific investigation which had founded the electrical engineering industry; in other words, it was the researches carried out by Faraday at the Royal Institution in London, purely as a scientific study which had brought the electrical industry into existence. The greatest discoveries were not due to industrial research, which was a commercial matter, and could almost be left to take care of itself. If a royalty of 1 per cent. for scientific research had been put on all inventions depending on Faraday's work, there would have been available much more than the £300,000, which had been suggested by Dr. Garnett. Sir Ronald Ross's discovery of the cause of malaria, namely, that it is due to infection by the bite of a particular mosquito, had resulted from work which had no official sanction and was, indeed, discountenanced, yet millions of lives had been saved by the discovery. This work of Ross's had also been largely instrumental in practically stamping out yellow fever in the Panama Canal region,

although he did not forget that the yellow fever investigation had originated in America after Ross's work on the mosquito. The true scientific man pursues investigation just where his fancy led him, and this was quite different from the research carried out with the object of finding a market for the result. With regard to the Advisory Council referred to by Dr. Garnett, this had been established in our usual fashion, and he, for one, was not impressed by it to the extent that Dr. Garnett appeared to be. It was under a Committee of the Privy Council, the members of which, except Lord Haldane, knew nothing about science. The Advisory Council was a very distinguished scientific body, but its officials did not come within that category. The Secretary of the Committee was Sir A. Selby Bigge, Secretary of the Board of Education, who did not pretend to have any knowledge of science. Then the Advisory Council had two secretaries appointed by the Board of Education, neither of whom had any particular scientific training, so that the very start had been made in an unbusinesslike way. If the Advisory Council was to be a living organisation, initiation by the executive officers was the great thing needed. The Government seemed to expect that men of science would come forward and help, and get nothing for doing so. Numerous committees had recently been appointed in connection with munitions and trade by societies and Government departments; and all the members were working for nothing. Men of science did not mind doing this during the war, but it seemed the general idea that they should be content to live on one or two hundreds a year, and provide the discoveries from which the manufacturers were to make their tens of thousands. Men of science did not propose much longer to be regarded as workers in garrets to be exploited, and it was necessary for the country to know this. Lawyers and other professional men did not give their services for nothing; neither the Attorney-General, nor the Solicitor-General, nor the medical consultants were working during the war for nothing, and therefore men of science should not be expected to do so. What was wanted was a Board or Institution

in which all science would be organised and brought into connection with industrial work. Such a body should embrace, not only chemistry and physics, but all branches of science, and should take under its control not merely the National Physical Laboratory, but a national chemical laboratory and laboratories dealing with other subjects. We wanted a Board in which scientific work could be brought together and put into relation with the educational and industrial organisations of the Kingdom. At present there was a most deplorable neglect in the provision made for publication, and the United States was an example in this respect in the manner in which the Bureau of Standards issued its publications, which were prepared most admirably and distributed widely to the technical press, and through them to the public. On the other hand, our National Physical Laboratory reported once a year in a document consisting of only about 50 pages or so.

Mr. L. PENDRED (the *Engineer*) remarked that all the memoirs of the National Physical Laboratory were published.

Prof. GREGORY agreed, but said they were very few, and there was little comparison between the publications of the Bureau of Standards and those of the National Physical Laboratory. It was important to have very free publication of the work done at all institutions of this nature. While our Government had been considering what it should do, the Commonwealth of Australia had practically established such a scheme as he had suggested. This scheme, which provided for the constitution of an Institute of Science and Invention, had been drawn up by Mr. Hughes, the Premier, who was at present in this country, and when Mr. Hughes returned to Australia a Bill was to be presented in Parliament and the Institute established. We had got a lead from Australia and he hoped that it would not be long before we were able to follow very closely what was being done on the other side of the globe.

The CHAIRMAN mentioned that the proceedings at this meeting would be reprinted, published in pamphlet form and distributed.

Mr. L. PENDRED (the *Engineer*) said there were one or two points in Prof. Gregory's remarks which he would like to refer to. Prof. Gregory was under some little misconception as to the way in which the work of the Advisory Council would be carried out. He (Mr. Pendred) happened to know a little more than was generally known of what was being done by the Advisory Council, and he believed it would be found that the final arrangements were such as would appeal to the general body of British manufacturers. Then with regard to the publication of scientific reports in this country, reference had been made to what was done by the National Physical Laboratory. This laboratory worked on the plan of allowing the members of its staff to issue to the press articles upon the work done in the laboratory; that appeared to be a very excellent way of distributing the knowledge broadcast. It also issued annually a book containing memoirs on a considerable number of subjects. The very important work that had been done in aeronautics, on screw propellers and air resistance, had all been published in special form. It must be admitted, he thought, that the National Physical Laboratory had endeavoured to spread the knowledge it had acquired. He would also like to add that the work done at the Yarrow tank at Teddington had been published almost annually in the reports of the Institution of Naval Architects. Similarly, the work done in alloys research had been published before the Institution of Mechanical Engineers in papers presented by the Alloys Research Committee.

He was so thoroughly in agreement with Dr. Garnett and Mr. Fleming that there was little to discuss, so far as their papers were concerned, but one point he would like to draw attention to was that there seemed to be a considerable feeling that science was going to do everything for this country. We must not be led away by the notion that we could put reliance in science and science only. We did not want a very much larger number of scientific men than were turned out annually, but it was necessary to have a greater number of people who took a sympathetic interest in science. We did not want everybody trained as scientists,

and he was very glad to see that Dr. Garnett in his sixth section laid stress on the value, for *certain* purposes, of a classical education. With regard to our associations and their work on research, Dr. Garnett stated that the British Association was the only one which had successfully attempted organised research. That, he thought, required a little modification. The Royal Institution, as all knew, had done a great deal of very valuable scientific research, for instance, Dewar's research into low temperatures. The work recently done also by the Institute of Chemistry was one of the most remarkable pieces of research work ever carried out. When the war broke upon us it left British manufacturers practically at a standstill for the lack of glass. It was impossible even to carry out the manufacture of guns, because we were short of a particular kind of glass. The analysis that was essential to the manufacture of steel had to be done in glass which all came from Germany and could not be supplied here. The Institute of Chemistry on its own initiative started a little research which was provided with £200 as funds. Later he believed the Advisory Council advanced an additional £500, and with that money the Institute of Chemistry—which had appointed Prof. Jackson of King's College to carry out the research—had produced a series of formulae for glass which enabled manufacturers to produce any glass required both for optical and laboratory work. He regarded this as a wonderful piece of work, in view of the fact that it had been accomplished in about six months.

Dr. R. MULLINEUX WALMSLEY (Principal of the Northampton Polytechnic Institute) could only offer a few disjointed remarks in the limited time available. He said that we had been treated during the last few weeks in the press to an anti-German campaign, and directions as to what we were to do to obtain German trade after the war. What Mr. Fleming had told us about America, however, indicated that we must look westwards as well as eastwards, for we should have very much keener competition in the first years after the war from the other side of the Atlantic

than from Germany. If we neglected the lessons taught by Mr. Fleming's remarks with regard to industrial research in the United States, we should suffer for it very seriously. He would like all journalists to keep that in mind; they could wield an enormous power in helping to meet that competition, which would probably have to be met by methods different from those which were promulgated to deal with the competition from the East. With regard to classical education, he would have very much liked Dr. Garnett to have gone further and to have said that our classical men, without neglecting their classics, should have a great deal more science. Notwithstanding their lack of science, however, one form of research had been highly developed by them, but it was not beneficial to the country, namely, the synthetic production of red tape. He could not agree that industrial research could be neglected. Industrial research had come to stay. He thoroughly agreed with all that Mr. Fleming had said on that point, and we had got to face it. It would be well for all those interested to do what Mr. Fleming had done, namely, take a trip to the States and see what was going on there in this direction on the spot. One point in Dr. Garnett's paper called for a little bit of caution, namely, the suggestion that teachers should learn trades. He hoped Dr. Garnett did not really mean that teachers should learn trades because he thought that if a teacher were set to learn something about industrial things, the temptation was for him to begin to think he knew all about the particular trade involved, and this would be mischievous. He would like to close with one more remark on the subject of industrial research. He had been approached during the last two or three days, and had agreed to allow one of his staff to be taken away from him to found a research laboratory in a works. He had been lent for twelve months for what was essentially industrial research, and it was hoped that he would come back again to educational work, although there might be some doubt about that.

Mr. W. R. COOPER (editor of the *Electrician*) agreed with Prof. Gregory that it was necessary to cultivate pure

science and the scientific man who investigates as the spirit moves him. With regard to the branch of research carried out by manufacturing firms, some people looked upon that as undesirable, and thought that manufacturers should not keep their own secrets. He could not agree with that point of view. Manufacturers were bound to go in for trade secrets, particularly in chemical work, because if a process was patented too much might be disclosed; hence the necessity in the chemical industry for keeping things secret. As Mr. Fleming had remarked, this sort of work required a good deal of money to carry out, and it would have been carried out in this country by manufacturers on a larger scale in the past if they had had more profit than was the case. Profits in many cases had been negligible, and it was quite impracticable to spend 5 per cent. of the profits when there were not any profits to distribute as dividends. The third class of research was industrial research on broad lines with State aid. This was a class of work which could not be taken up by either the pure scientist or the manufacturer. In this category could be mentioned such work as insulating materials and the dissipation of heat in rotating machinery. Dr. Garnett had mentioned State patents, but he must confess that he had not any faith in that class of thing at all, because when it came to licensing more than one individual it was really impracticable from the commercial point of view. Anyone who had a licence had to spend money to get a market, and if the market was to be divided up between two or three people, A would not spend money because he thought B would benefit by it and firm C likewise. He agreed with industrial banks, although we could not expect our existing banks to go in for such work. One of the greatest difficulties in launching new things was the financial one, and if the company promoter could be eliminated it would be a great advantage. At the same time the British manufacturer should have a little more go in matters of this kind. At present when the manufacturer saw something new, he was satisfied with the fact that he was earning money at the moment on something else, and he therefore neglected

the new product which would not bring him in money for, say, two or three years. He allowed a few years to go by with little effort, and then after fourteen years when the patent expired he asked for a renewal. There must be more industrial education, and it must be on the right lines. It was contrary to human nature to expect youths to put in several hours per evening at schools after eight or nine hours in the shop. He had tried it himself, and he was sure that good results could not be expected from that kind of thing. The employer must look at it from a higher standpoint. With regard to the press, he did not quite know what was in the mind of the meeting. In his opinion, there were two or three spheres for the press. First there was the question of education, and that applied quite as much to the lay press as to the technical press. If we did not get the man in the street to appreciate science it was not much good. Even if he were made to believe in perpetual motion it would be better than nothing, for it would raise his interest in science. Without this appreciation we should never get any grants from the Government, for in addition to there being ignorance on the part of the man in the street, there was also ignorance on the part of people in Government offices who ought to know better. The second point for the press was to give publicity, and for that purpose it should certainly be in close touch with the Privy Council Committee or the other Committee, whichever might be best, whilst a third function was to criticise. If there was to be any collective action it must be on broad lines. It was not the part of the press to originate anything in the way of research. That must be left to technical societies.

The CHAIRMAN, in closing the discussion, said that the subject was obviously one of very great interest to the Circle, and he hoped that several meetings would be devoted to its continued discussion, so that the various points raised in Dr. Garnett's paper and the remarks made by various speakers could be fully considered.

He would now call upon Mr. Gilbert Wood to propose a resolution expressing the views of the meeting.

Mr. GILBERT WOOD said the resolution he had to propose was in three sections, as follows:—

(1) *That this Meeting recognises that Technical Education and Industrial Research are of great benefit to the manufacturers of the country.*

(2) *That the Circle of Scientific, Technical and Trade Journalists is prepared to assist the promotion of unity of effort on the part of the various associations and committees engaged in the study of this subject.*

(3) *That the Scientific and Technical Press be used as a medium for the dissemination of information of value to the industries of the country, thus bringing about a fuller appreciation of the value of Technical Education and Research.*

Mr. J. S. Dow, briefly seconding the resolution, said that the greatest need at the moment was to raise the standing of scientific work in the public mind—to educate manufacturers and the public to believe in the existing scientific and technical organisations, and give them fuller support. People who criticised our institutions and colleges of this country were apt to forget how very much greater were the facilities given abroad. As an instance Mr. Dow referred to the great technical schools of Germany and the marvellous educational organisation in Switzerland, a little country with a population less than that of London, but having no less than seven important Universities. Mr. Dow also recalled a Report by Dr. Gregory in the *Journal of the British Science Guild* last year, in which figures for the support given to applied science in various countries were quoted. There was one Institution in the United States which alone received each year for the prosecution of scientific work twice as much as the total official grant for scientific work of all kinds in this country.

He hoped that the work of the Circle would have a useful influence in promoting a better appreciation of the value of applied science; the creation of this feeling was a necessary preliminary to any real progress towards the full utilisation of our scientific resources.

Dr. GARNETT, briefly replying to a few of the points in the discussion, said that our present Patent Law system was too much regarded by patentees merely as a means of granting monopolies, whereas the true purpose of the Patent Laws was to grant such protection only as would make it possible to manufacture the new invention, and that was the point he had in mind when speaking of this matter. Dr. Walmsley had stated that he did not want secondary school teachers to be taught a trade. He (Dr. Garnett) entirely agreed, but would like to send such teachers to Dr. Walmsley for a year to have the run of his technical classes and work in his laboratories, because he was sure the result would be to the general benefit of the boys with whom those teachers had to deal. Mr. Pendred had pulled him up for saying that the British Association was the only body which had been successfully organising research. He admitted that he ought to have been careful to explain that he did not mean to include in this the valuable work done in organising scientific work since the war broke out. At the beginning of the war a big optical firm came to one of the London schools to borrow 2 lb. of barium crown glass to enable them to complete an Admiralty contract, but not many months after he saw a 60 lb. lump of beautifully clear barium crown glass which had been made as the result of some of the combination of science and industry which had been brought about during the last few months. Neither did he include in his remarks such work as that done by Sir James Dewar or any other individual worker. He referred to the work done by such Committees as the British Association Electrical Standards Committee which on occasion had rendered most

valuable service in *organising combined scientific research*. Prof. Gregory had distinguished between scientific investigation and industrial research and he was sorry if he had made any confusion himself between them because he had the clearest definition in his own mind between the purposes of the two, though in practice they frequently overlapped. It was with a clear view towards a definite industrial result in connection with synthetic indigo that the Germans spent a million of money before they destroyed our Indian indigo industry. What was wanted was a Council to advise, organise and aid industrial research, so that we could render of commercial value quickly all scientific discoveries. There had been too long intervals between the earliest scientific discoveries in this country and their practical application.

Mr. A. P. M. FLEMING also briefly replied to the discussion. He had been much struck by the fact that in many laboratories in the United States men who were engaged in regular industrial research work were also carrying out investigations in pure science. Therefore, while he agreed with Prof. Gregory that there was a distinction between the two, both forms of research were often undertaken simultaneously in the same laboratories.

Another point was the collection and dissemination of information. In addition to the Bulletins of the Bureau of Standards, data were distributed by a number of University experimental stations throughout the United States, and the publications of the Department of Agriculture, in particular, furnished an excellent example of work of this kind.

RESUMPTION OF DISCUSSION ON MAY 16th.

The discussion was resumed at a meeting held in the Hall of the Institute of Journalists, at 5 p.m., on Tuesday, May 16th, the Chair being again taken by Mr. L. Gaster, who delivered an introductory address, summarising events of importance in relation to the organisation of science since the last meeting on March 14th.

Mr. Gaster remarked that there was in this country a growing recognition of the value of applied science. As a preliminary to future progress it was, however, essential to educate public opinion to appreciate more fully the benefits of research so that the country might be prepared for the labour and sacrifice which scientific organisation demands.

The scientific press, which reaches such a variety of industries, could do good work in this direction, and also by promoting unity of effort on the part of those interested in the organisation of science. These two aims were expressed in the Resolution passed at the last meeting.

But in order to carry out their aims journalists should themselves become students, keep themselves informed of the latest progress, and understand something of the fundamental principles of education. Dr. Garnett and Mr. Fleming had placed before the Circle a very comprehensive survey of the subject at the last meeting and he proposed to give a short summary of various proposals for the improvement of technical education and the organisation of scientific research, up to the date of the present meeting. Public interest in the subject had developed mainly about the middle of the last year. The scheme for the Organisation of Industrial and Scientific Research, under the Privy Council was announced at the end of July, 1915, and the preliminary arrangements were doubtless made a considerable time earlier. Those who were inclined to criticise the Government for the neglect of science should, therefore, in fairness recognise that although much remained to be done they had taken steps at quite an early stage in the discussion.

Among events of importance during 1916 may be mentioned :—

The Memorial, signed by 36 leading men of science, advocating fuller representation of science in the service of the State, and ultimately a Ministry of Science, Commerce and Industry Feb. 2nd, 1916.

(This Memorial was afterwards endorsed in an Appeal from the Imperial College of Science Feb. 21st, 1916.)

A Paper on the Organisation of Scientific Research was read by Professor Fleming before the Royal Society of Arts Feb. 9th, 1916.

The last Meeting of the Circle of Scientific, Technical and Trade Journalists, at which Dr. Garnett's paper was read, took place on March 16th, 1916.

A meeting attended by representatives of the chief scientific and technical societies was called by the Royal Society and a Resolution passed empowering the committee to draft a scheme for a Conjoint Board of Scientific Societies, in order to promote the co-operation of those interested in pure and applied science, encouraging the application of science to industry, &c. March 22nd, 1916.

An account of the work initiated by the Advisory Council of the Committee of the Privy Council on Industrial Research was made public, mentioning research and grants allotted for experiments on tests of hardness, composition of alloys, laboratory and optical glass, methods of extracting tin and tungsten, &c.

March 24th, 1916.

A further paper on Engineering and Scientific Research was read by Prof. J. A. Fleming before the Society of Engineers on

May 1st, 1916.

A meeting was called by the Neglect of Science Committee, and a Resolution passed urging that the natural sciences should form an integral part of the education of the country, and that a knowledge of them should be required in the Civil Service and by candidates at Sandhurst May 3rd, 1916.

A further statement of work done in connection with the Advisory Council of the Committee of the Privy Council was made at the first meeting of the Standing Committee on Metallurgy, when Sir Robert Hadfield gave an address advocating the extension of metallurgical research, particularly in regard to the production of special steels, methods of hardening, the application of photo-micrography, high temperature measurement, &c. May 8th, 1916.

The above statement by no means exhausts the number of proposals, and the broad question of correlating the investigations being made independently by many societies, colleges, and institutions throughout the country requires full discussion.*

Mr. Gaster added that there were present several gentlemen who had taken a great interest in these questions, and they hoped to hear their views in the course of the discussion. Among others, Lord Rayleigh, Lord Sydenham, Lord Montagu of Beaulieu, Sir Phillip Magnus, and Sir Harry Johnston had written expressing regret at their inability to be present. A letter had also been received from the Secretary of the Royal Society, explaining that the proposals for forming a Conjoint Board of Scientific societies are in embryo at present, but approving the co-operation of the scientific and technical press in regard to these matters.

The great need in this country is the co-ordination of separate efforts and the development of an organisation for more effective co-operation between scientific

* (On the day following this meeting (May 16th) the Tenth Annual Report of the British Science Guild was issued. The Science and the State Committee of the Guild is stated to be considering the question of obtaining for science "a more generous recognition" in public affairs, and a Report on the matter will be published later.—ED.)

and technical men. With a view to promoting such co-operation it was desirable that individual proposals should be fully discussed in the press at an early stage. Moreover such co-operation need not be limited to this country. It is desirable to associate the efforts of workers in other parts of the world. One of the most interesting events during recent months had been the Conference called in Melbourne to consider a scheme for a Federal Institute of Science and Industry. Mr. Hughes, the Prime Minister of Australia, had kindly consented to be present at the meeting, and they hoped to hear from him something of the important scheme proposed by the Australian Government. These proposals had for their object the organisation of applied science and industrial

research throughout Australia, and included the establishment of a Bureau of Information for the interchange of experience between manufacturers and men of science. The progress of the scheme would be watched with keen interest in this country.

In conclusion Mr. Gaster said that his object in making these remarks had been to supplement the addresses of Dr. Garnett and Mr. Fleming at the former meeting, by a synopsis of recent events in part directed towards the practical realisation of the aims set forth in those papers.

He had much pleasure in calling upon Professor R. A. Gregory to open the discussion.

Professor GREGORY then read in abstract the following communication :—

EDUCATION, SCIENCE AND INDUSTRY.

By PROFESSOR R. A. GREGORY.

Three prime points to which attention should be directed may be distinguished in Dr. Garnett's paper, read before this Circle at the meeting on March 14th; they are :—

(1) More practical studies, and less academic instruction, in all schools, and an increased number of specialised technical institutions, as well as of advanced students of technology.

(2) Adequate encouragement of scientific research and provision for its application on a commercial scale.

(3) Co-operation between Trade Association and the Advisory Council on the Development of Scientific and Industrial Research, as well as with the laboratories of local technical colleges and universities.

Education, science, and industry are respectively represented by these three points; and the co-ordination of the efforts of them all is required in order to reach the common end.

The need for more scientific teaching in elementary schools was stated by Mr. C. W. Crook in his recent address as president of the National Union of Teachers. "What is needed," he said, "is the scientific spirit, which should, and must, direct the teaching of all subjects, not omitting the essentials of

formal English, so that our children may proceed to sound judgments by accurate reasoning upon clearly viewed facts."

As regards research, it may be divided conveniently into two classes—one in which the motive is solely the desire to extend the boundaries of knowledge, while in the other the special purpose is to obtain results which have a direct bearing upon problems of manufacture and construction. Purely scientific investigation has, however, led to some of the greatest industrial advances, as, for example, the development of electromagnetic machinery from Faraday's experiments, and wireless telegraphy from the work of Clerk Maxwell and Hertz.

Industrial research, that is, research from the point of view of commercial profit, may come out of purely scientific investigation; and belief in the value of each is necessary for national advance. In the field of great discoveries in science, Great Britain takes a leading place; but in industrial research manufacturers in the United States and Germany are easily ahead of us. The result is that opportunities for highly-trained technologists are more favourable there than here. It has been estimated recently that for each 1,000 chemists in Germany, there are only 24 in England, where a chemist

is unlikely to receive a greater salary than that of an intelligent artisan or clerk. Largely on account of the poor prospects of technically-trained men in the British Isles, the number of students of advanced science and technology is far less than in Germany. As the Report of the Board of Education pointed out last year, "the provision for full-time education in applied science is regrettably small in bulk compared with the industrial development of the country."

Manufacturers are beginning to appreciate the value of science to industry. At the last meeting of the Central Executive Committee of the Employers' Parliamentary Association a resolution was passed urging the necessity (1) of increasing the number of chemists trained in research work, and (2) of making special efforts to enlist the co-operation of manufacturers who hitherto have been lamentably apathetic in regard to scientific industrial research and training. The first of these results can be attained by increasing the position and prospects of men who devote themselves to the study of chemistry; and the way to effect the second is to see that everyone—particularly men who are to become masters of great works on account of family relationship or influence—receives a certain amount of scientific education. The possibilities of science can only be appreciated by people who have had instruction in scientific subjects; and the lack of such instruction in the courses mostly followed in the public schools and the ancient universities is our chief defect in the training of capitalists, manufacturers, and legislators.

By organisation, by co-operation among our manufacturers, and by education in science of directors as well as artisans, industrial advance can be secured. At present, science, industry and education are working in separate fields, whereas their efforts should be combined. The Royal Society, with a number of other scientific societies, has established a Conjoint Board for the purpose of organising scientific effort in this country; and similar organisations of technical experts have been brought together by engineering societies. The British Association is obtaining from each of its sections views as to the assistance which they may afford

to national development. Sir Ray Lankester has obtained a distinguished body of opinion in favour of a change in the position of science at the public schools, at Oxford and Cambridge, and in the examinations for the public services; and the Re-organisation Committee, of which he is chairman, is limiting itself to this field. An Education Reform council has been formed to deal with all branches of education in relation to modern needs; and various commercial and industrial bodies have passed resolutions relating to education and science as essential factors of progressive industry.

What seems to be particularly needed is a combination of the forces of education, science, manufacture, and commerce, instead of the separate representation of these interests. The British Science Guild exists for this purpose; and it has upon its committees and among its members leading representatives of all these interests. Membership is open to every British subject; and all who believe in "the necessity of applying scientific treatment to affairs of all kinds" should strengthen the influence of the Guild by joining. When opinion is united as to national needs, it will be possible to secure the reforms now urged separately by education, science, and industry.

The Advisory Council may do much to promote this combination; but its constitution and functions should be greatly widened if they are to embrace the whole of the British manufactures, except rural industries, which are provided for by the Development Commission. It should eventually become a Board of Science and Industry, such as has been established by the Commonwealth of Australia, and be directed by men of high business capacity and scientific knowledge. Such a Board would serve as a scientific intelligence department, and would, among other matters, promote the co-ordination of industrial effort, secure connection between manufacturers and the laboratories of universities and colleges, and distribute information of a scientific and technical character. It would, in fact, perform most of the functions of the Ministry of Commerce, recommended by the Sub-Committees of the Board of Trade in its recent report on British trade after the war.

Sir JOHN COCKBURN said that the enormous strides which Germany had made in science and industry rested for the most part upon ideas which had been initiated in this country, while it was a further fact that for years past Great Britain had, so far as industry was concerned, been gradually falling into the hands of Germany. It was indeed by the exploitation of our trade that Germany had acquired the wealth which tempted her to provoke the war. Consequently unless we took steps to put the application of science and industry on a sounder footing we should find after the war this process still continuing and the Empire placed in still greater jeopardy by the coming industrial war than by the present terrible conflict.

He fully agreed with the great importance of making instruction not only in elementary schools and secondary schools, but in the technical schools themselves more practical. Thirty years ago in Australia he studied this matter and found excellent results followed from changing applied mechanics from a classroom subject to a workshop subject.

He wished to emphasise one point and that was that many drawbacks from which our industries suffered were not due to any inferiority in our technical schools because they were equal if not superior to anything in Germany; but the one great advantage that the German technical schools had was that when the students had completed their course they had a career open to them, whereas in this country they found themselves in a blind alley. It was no use training students technically unless there was scope for them afterwards to utilise their accomplishments. One might as well attempt to teach swimming without water in which to exercise the art, and although we might possess technical schools of a magnitude and excellence unsurpassed by the world our efforts would be for ever vain unless steps were taken to render those great scientific industries which this country had lost safe from foreign control and usurpation in the future.

The manner in which the dye industry was lost to this country was an instance of the greatest neglect and want of foresight on the part of the authorities. It

was much to the credit of the Technical Circle that they should have taken this matter up and he hoped that the result would be a correction of the faults of the past generation which had prevented students from reaping the just reward of their labour in after life.

Mr. GERALD LIGHTFOOT, Advisor to the Ministry of Australia, first apologised for the absence of Mr. Hughes, who had been prevented from attending the meeting, the more particularly as this subject was one in which Mr. Hughes had himself taken the initiative.

A conference had been convened in Australia by the Government, comprising not only the leading scientists, but also the representatives of industries with a view to formulating some scheme for the promotion of scientific research and the application of science to industry. That conference took place in January last before Mr. Hughes left Australia for England, and a committee was appointed with a view to formulating the general outlines for a scheme for the consideration of the Government. A Report was presented by the Committee, but the scheme had not yet been adopted by the Government, because Mr. Hughes desired to obtain information as to what was being done in America and England before the Government came to a decision. Nevertheless, matters had already been put in train in Australia, and an assessment was being made by a provisional committee of the existing personnel and material with regard to scientific work in order to co-ordinate the existing facilities and to set on foot some investigations in relation to our most pressing industrial problems.

Briefly outlined, the Australian scheme proposed to establish a Federal Institute of Science and Industry. The organisation would consist of an Advisory Council of nine members with an executive directorate of three members. One of these three, the Chairman, would be selected not necessarily because he was a scientist, but because he was a man who, in the course of his experience, had acquired an appreciation of the application of science and industry, a man of wide ability and experience. The other two members would be selected mainly on account of their scientific qualifications,

and also on account of wide experience. These three members would confer with the Advisory Council, but they would not necessarily take the advice of the Advisory Council, because the whole responsibility of the executive administration would be cast upon the executive directorate of three. The directors would be free from political control, and the members would be appointed for a period of about seven years: the members would practically be on the same status as the judges of the High Court of Australia, being paid salaries of between £2,000 and £2,500 per annum. These would be removable only by resolution passed by both Houses of Parliament.

The scope of the Institute would be not only to deal with the secondary industries, but also with the primary industries, including agriculture, the pastoral and horticultural industries, as well as mining and metallurgy. One of the most important functions of the directors would be to go about the country and inform themselves either by technical evidence or with the co-operation of sub-committees of technical and scientific societies as to what problems should be taken up for investigation. It would be their duty to allocate the work of investigation to existing institutions, such as the universities and other laboratories. Then the Federal Government would furnish liberal grants to enable the work to be carried out. In this way it is hoped to stimulate and co-ordinate scientific work in the Universities.

The second main function of the directorate will be to establish a bureau of information, the duties of which will be not merely to disseminate information, but to collect it also for the benefit of the manufacturers and industry generally. A vast amount of information is available, and there is no reason why it should not be made available with the result that productions would be increased enormously.

Thirdly, in the course of carrying out this work, it is considered that the directors will no doubt come to the conclusion that certain important investigations of a fundamental character should be carried out, and it would be their duty to recommend the establishment of federal institutions, which would be

liberally endowed by the Commonwealth Government. It was somewhat early at present to indicate what the nature of these institutions would be, but it was thought that there would be at least a national physical laboratory and national chemical laboratory. The opinion was that the field should be divided into physics, chemistry, and engineering, and each of these would have to be considered and dealt with separately. Very fine laboratories had already been established and equipped at the Universities. Some sort of agricultural organisation would have to be established perhaps somewhat on the lines of that at present at work in America, which appeared to be exceedingly efficient. The Government would co-operate with the existing institutions such as the Universities, and every endeavour would be to promote co-operation, not only between the learned and scientific societies, but also between the employers' associations.

Mr. Lightfoot attached much importance to the establishment of a scheme on an Imperial basis. Inquiries he had made in England led him to believe that the first step that must be taken before the Imperial co-operation could come into effect was the organisation of some central authority in England. This was essential before any steps could be taken to promote any organisation on an Imperial basis, and if this were done there were institutions in England which were most admirably equipped for certain classes of investigation. If some scheme of co-operation were established many problems of a pressing nature might be solved, to the mutual advantage of England and the Dominions. He had in mind the Metallurgical Department of the Sheffield University and the Textile Department of the Leeds University. An Imperial scheme should provide for a central clearing house from which all the information available would be distributed, a scheme of this nature should lead to great efficiency and to the elimination of waste of money, and duplication of effort.

At this point the Chairman, after thanking Mr. Lightfoot for his remarks, read a telephone message just received from Mr. Hughes's secretary to the effect

that Mr. Hughes greatly regretted his unavoidable absence, but had been called away on important national duties.

The Rt. Hon. ARTHUR DYKE ACLAND said the great difficulty in this matter was to make public opinion understand that education is really an asset of national welfare and prosperity, but he believed the time was coming when the public would be convinced that this was a matter which deserved the attention of the whole State, and particularly Parliament. He recommended the Circle from this point of view to concentrate upon certain definite recommendations which should ultimately be brought before Parliament, because if the House of Commons could be convinced a very great public service indeed would have been rendered.

He recalled the efforts which had been made by a small band of people during the last thirty years to bring about an improvement in the secondary education of the country. He said it was interesting to remember as an illustration of our haphazard ways that the first important sum allotted by Parliament to technical education often called the whisky money, about three-quarters of a million a year had been intended as compensation money for the brewers and distillers. As regards the advisory Committee to the Privy Council on Industrial Research, he knew that the Committee would be largely left a free hand, and that the Privy Council Committee itself would desire not to interfere.

The great thing that was wanted was more money if the work was to be successfully done, and if leaders of industry would really believe that science was going to help them a very great deal more money should be available than the £40,000 at present voted to the Privy Council Committee. He was not in favour of the appointment of a Royal Commission to deal with these problems, because it was necessary to move in a much greater hurry than a Royal Commission usually permitted.

After paying a tribute to the magnificent equipment of the Imperial College of Science, Mr. Acland urged the necessity for providing greater facilities by way of scholarships for boys in the elementary

and secondary schools, many of whom, he said, had greater intellectual abilities than others more fortunate in their social station in life. On this other question of class education he urged that Oxford and Cambridge should not be allowed to bar the way with their compulsory Greek, and he wished the Circle could persuade Parliament to take these things up and not be afraid of Oxford and Cambridge in this matter. The best men at these Universities had longed for reform for generations, and Parliament should be asked to legislate to remove some of these obstructions. Hitherto we had been too much afraid of the vested interests. Full efficiency in Government would never come until those in the Civil Service, the House of Commons, and even Ministers themselves were men who appreciated the value of a scientifically trained mind.

Teachers in secondary and technical schools also were badly underpaid, and a million a year could be spent usefully in improving the salaries of these teachers, and in giving the boys of sixteen and upwards a very much larger supply of Government bursaries and scholarships. Germany gave State grants to her University of about a million a year, whereas our grants to the Universities amounted to only £300,000.

Mr. A. J. MUNDELLA, as Chairman of the London District of the Institute of Journalists, congratulated the Circle on the excellent work it was doing. A point in Mr. Acland's speech which appealed to him was the need for more scholarships for the boys in lower class schools, and he hoped that in the propaganda for the extension of scientific education special consideration would be given to them. At present 92% of our children went through the public elementary schools and surely it could not be said that the scientific intellect would be found only in the others. He contended that in the children of what was called "the elementary school class" there was material for scientific training which would give as good results as were obtained from the education of the 5% whose social position enabled them to go to other institutions.

Mr. A. A. CAMPBELL SWINTON, representing the British Science Guild (*communicated*):—For the reason, as I suppose, that historians are usually not scientific men, histories in most cases give a very misleading account of the chief factors that have influenced the progress of the world. True, if we go back far enough, and survey the little we know of history in the time of pre-historic man, we realise that, so far as those very distant epochs are concerned, the predominant influence of such science as then existed, is recognised by the fact that we talk of the Stone Age, of the Bronze Age, and of the Iron Age, to denote those vast periods during which the primitive inventor was discovering the means of applying new and improved materials to what was then the great necessity of man, namely, weapons for the chase and for defence and offence against his enemies.

Coming, however, to more modern times and surveying the forces which have directed the civilisation of the world, say, during the last thousand years, we find that, though during this period there have been sanguinary wars, great political upheavals and vast revolutions, and at the same time there have lived great kings, successful generals, and far-seeing statesmen, all of whose doings you will find fully described with an enormous amount of detail in hundreds of histories; still, if you wish to know what are the three things that in the course of the last millennium have had paramount influence on the history of the civilised world, and have had most effect in producing the material conditions under which we live at the present time, they are not the work of rulers or leaders at all. On the contrary, they are scientific inventions, namely, the invention of gunpowder, the invention of printing, and the invention of the steam engine.

The first of these, the invention of gunpowder, entirely changed all the conditions of warfare: it did away for ever with the knight in armour, and with him the feudal system, and precluded for all times the recurrence of what occurred when Roman civilisation was overcome by the barbarians.

Then again, the invention of printing was the soul of the Renaissance, and of

the revival of learning; while who can exaggerate its effects on the diffusion of every description of knowledge?

Finally, in the steam engine, with the resulting railway and steamship—none of which would probably have yet seen the light had it not been for the impetus that was given to every kind of endeavour by printing—we have an invention to which we owe all the major differences between the lives which civilised men live to-day, and those they lived a century ago.

There are also more modern inventions, such as the telegraph and the telephone, which to-day have an enormous influence upon the conditions of our existence, while still more recent are wireless telegraphy, and aviation, the possible developments of which are beyond what we are at present able to estimate.

What, however, I wish to emphasise is this: it is not the ruler, it is not the statesman, or politician, it is not the great soldier or sailor, nor is it all these in combination, who really direct the course of civilisation. In the case of these leaders of men most of what is accomplished by one man is sooner or later rendered nugatory by another, while much more potent in the long run than anything that they can do, is the work of scientific discoverers and inventors. These latter work for the advantage, not of one nation against another, but for the benefit of all mankind. Moreover, the results that they effect, are cumulative, and so far as they are not limited by the duration of human existence, they are everlasting. It is for reasons such as these that there is to-day a feeling abroad that more science should be taught in our schools and universities, and that scientific research and invention should be further stimulated in connection with all our industries.

Dr. GARNETT, replying briefly to the discussion, first moved the following Resolution:—

That this meeting urges upon the various Associations, Institutions and Committees engaged in the consideration of Technical Education and Industrial Research the necessity for co-operating in order to present a National Scheme for the consideration of the Government.

That in any measures taken for the preparation and execution of such a National Scheme the co-operation of the Scientific and Technical Press should be secured.

That this meeting is of opinion that the Press should use its influence to encourage the teaching of Science in Schools and Colleges of all grades, and to determine the proper position of Science in Civil Service and other examinations, especially with reference to the influence of these examinations upon Education.

That in the meantime it is desirable that all possible support should be given by the Press and the Public to the work of the Advisory Council to the Committee of the Privy Council for the organisation and Development of Scientific and Industrial Research, and that Industrial Associations should report to the Advisory Council on the facilities required for the conduct of Research in connection with their particular industries.

Nearly everything that had been said in the discussion was in accordance with the views he had attempted to express, and consequently he had little to answer. There seemed to be a consensus of opinion that in this country we are quite ahead of the world with regard to purely scientific research from which great industrial developments immediately come, but a long way behind Germany and the United States in connection with that form of industrial research which takes up a discovery and adapts it to the requirements of industry and commerce. It was in this latter connection that considerable help was necessary from the Advisory Council for Research. With regard to the criticisms that had been made of this body it should be remembered that both the Board of Education and the Board of Trade started as a Committee of the

Privy Council. This seemed to be our way of doing things, and when the Committee had earned its footing the authorities allowed it to develop into a department of the State under a special Minister. He was not at all sure that we did not obtain advantages in that way in the early stages because such a body was less under political control than if it were under the direction of a Minister responsible to Parliament. Scientific Societies, and more especially trade associations should utilise to the utmost the opportunities which were afforded by the Advisory Council, at any rate until we got something better, if ever we did.

A great deal had been heard about reform in regard to science subjects in Civil Service and other examinations, and the reform of these public examinations was most important on account of the enormous influence which they exerted on the educational curricula of our schools. At the same time we must clear up our ideas as to what was meant by the position of science in Civil Service examinations. Those going in for high positions in the Civil Service should not only have a general knowledge of English literature and some modern languages but a general knowledge of science, the special subjects in any particular examination being adapted to the work for which the individual was intended, as for instance the telegraph and engineering departments of the Post Office, and so on. Thus while all Civil Servants would have a general knowledge and appreciation of science, the competition for the scientific appointments in the Civil Service would be in science and the allied subjects, and no question would ever arise as to the relative credit to be given to chemistry and Greek.

Mr. H. J. P. BENN seconded the resolution proposed by Dr. Garnett, and the resolution was put to the Meeting and carried unanimously.

The proceedings terminated with a vote of thanks to the Chairman.

VISIT TO THE IMPERIAL COLLEGE OF SCIENCE.

FOLLOWING the discussion summarised in the preceding pages, members of the Circle and friends paid a visit to the Imperial College of Science (South Kensington) on May 31st, at the invitation of the Rt. Hon. Arthur Dyke Acland, Chairman of the Executive Committee. The party was received and addressed by Mr. Acland and the Professors, several of whom gave interesting particulars of research work carried out since the outbreak of war. Professor Baker, in the chemical department, referred to several particularly important investigations which, although carried out originally in the laboratory on quite a small scale, had been conducted with a view to their subsequent application under practical conditions, and had led to most important developments.

Mr. Acland drew attention to a Memorandum which had just been prepared and signed by the staff of the College and addressed to Lord Crewe (the Chairman of the Governors). The Memorandum emphasises the vital importance of securing a fuller recognition of science in education, and the urgent need for additional support for the development of research, particularly in the matter of founding bursaries for gifted youths of 16—18 years of age, from whom scientific workers should be recruited. It is pointed out that while in Germany the State issues grants to universities of the value of about one and a half million each year, in this country the corresponding amount is less than a quarter of a million.

The visitors were then conducted over the laboratories and workshops of the College, which now extend over a considerable area. Great interest was expressed in the well-equipped chemical laboratories, the electrical and mechanical

engineering departments (City and Guilds section) and the working examples of mineral-separation plants and other metallurgical operations. A visit was also paid to the research laboratory on combustion, where Prof. Bone gave a short account of the investigations being made on fire-clay and other matters. To many of the visitors it came as a revelation to find what a variety of work was already carried on and how great were the future possibilities of the College.

Subsequently the party was entertained to tea by Mr. Acland and the Professors. A vote of thanks to the hosts was proposed by Mr. Gaster (Chairman) and seconded by Mr. Gilbert Wood. Mr. Acland expressed the hope that the visit would be helpful in promoting closer co-operation between the press and men of science, and in fostering an interest in the Imperial College of Science as a great national institution, in which they might all take a legitimate pride. He also extended an invitation, which was endorsed by the Professors, to members who wish to receive fuller information on the work of particular departments, to make arrangements for a further visit with the Professor in charge, who would be only too glad to offer every facility.

INDUSTRY, EDUCATION AND RESEARCH.

THE attention of members of the Circle may be drawn to an important paper on the above subject, read by Dr. W. Garnett at the Annual Spring Meeting of the Textile Institute on May 5th. The paper discusses many of the subjects referred to in the recent meetings of the Circle, and forms a useful supplement to the address delivered by Dr. Garnett before the Circle on March 14th.



TOPICAL AND INDUSTRIAL SECTION.

— • • • —

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]



HOLOPHANE ILLUMINATION ON THE RAILWAY.



FIG. 1.—Illumination of the New Booking Hall at Euston Station with Holophane reflector bowls.



FIG. 2.—First Class Dining Coach, Great Central Railway, lighted with special Holophane glass units and "half-watt" lamps.

The lighting problems met with in railway work are distinctly varied, and we understand that Holophane units have recently been adopted by the chief railway companies for quite a number of different purposes. Apart from the utility of the standard types for lighting offices, booking halls, waiting rooms,

&c., there are considerable opportunities for special contrivances in railway carriage lighting, where the methods of companies differ to a somewhat surprising degree.

Fig. 1 shows the lighting of the new booking hall at Euston station. The centre line of units consists of 200 watt

lamps in 16 in. reflector bowls, while for the side lines 14 in. units with 100 watt lamps are used. The fittings, with parallel chains, are of special design.

Fig. 2, showing the arrangements in a first class dining car on the Great Central Railway, is interesting as an example of the use of 60 watt "half-watt" lamps for carriage lighting. The lamps are enclosed in special Holophane units made up of a 12 in. reflector top and corresponding "Excellite" (diffusing

glass) bottom. The units are mounted direct on the ceiling. The effect is striking and the freedom from glare is doubtless a good feature.

We understand that the new industrial units, with aluminium-covered exteriors are also being widely used, particularly in some of the large munition factories. It is naturally impracticable to publish particulars of such installations at the present time, but no doubt full information will be available when the war is over,

MANUFACTURE OF BENJAMIN REFLECTORS AND FITTINGS.

We were recently afforded an opportunity of visiting the works of Benjamin Electric, Ltd., where a great variety of reflectors for industrial lighting is being manufactured and other special war work is being done.

Probably few people realise the variety of operations involved in the production of these reflectors. The forming of the special contours requires a series of

stamping processes, and the reflectors have to be annealed between each step. Then there are the subsequent operations of coating the outside and preparing the aluminium and rust-proof lacquer-protection for the interior. Some of the reflectors require at least a dozen distinct operations. Fig. 2 shows a view of the powerful press used for this work which, we understand, has been kept pretty

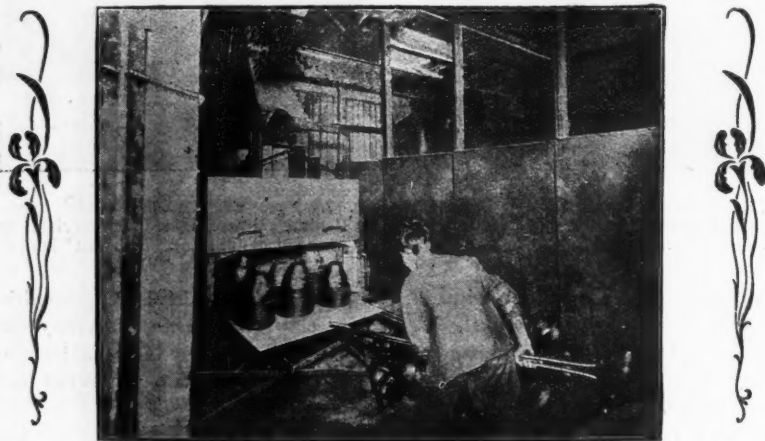


FIG. 3.—Reflectors being annealed.

continuously employed since the war commenced.

Among other operations of interest are the fitting together of Benco holders, safety-portable lamps with insulated handles and special sealed reflectors for munition work. The latter are of very solid construction and the lamp is effectually protected by a thick well-glass screwed into the reflector, so that gases and fumes in the atmosphere of the workroom cannot find their way into the interior of the unit. The reflectors are spun by hand on the lathe. The company has also been making a series of aluminium trays for the handling of acid and other materials. These must contain no joins and are also spun by hand. Seeing that some of these pans and trays are as much as four feet in diameter the work calls for considerable effort and the highest degree of skill.

There were also to be seen special reflectors made for various Government departments, one of them a new unit built up of diffusing glass, which should be very effectual in preventing glare. Another interesting item was the making of a series of large "artificial daylight" units, which, we understand, are required for special munition work in which correct colour-definition is of great importance.

A visit to these works is interesting as showing the considerable amount of extra work involved in producing metal reflectors with special contours. One can understand that the manufacture of ordinary conical shades is a much simpler matter. But the extra labour involved is compensated by the greater utility of properly designed reflectors from an illuminating standpoint, and it is satisfactory to note that the work done by the Benjamin Electric, in the field of industrial lighting during recent years, is now receiving adequate recognition.



FIG. 1.—Spinning special reflectors for lighting munition works.

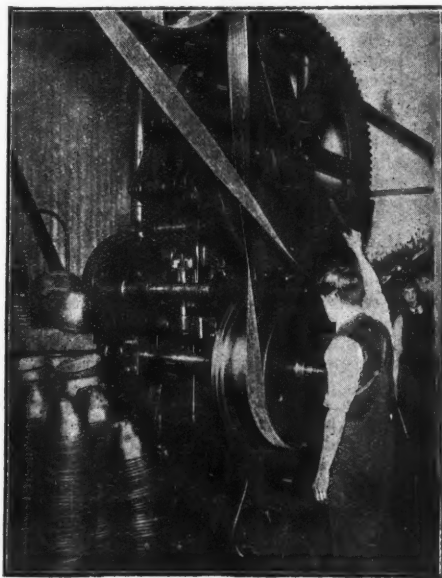


FIG. 2.—Showing the press in which the reflectors are stamped out.

REVIEW OF BOOK.

The Principles of Apprentice Training, by A. P. M. Fleming and J. G. Pearce. (Longmans Green and Co., 1916. 202 pages.)

IN view of the recent discussions on Technical Education and Industrial Research at meetings of the Circle of Scientific, Technical and Trade Journalists, which have been summarised in this and the preceding number, the above volume is very welcome.

The book is divided into four parts, dealing respectively with The Economic Aspect, Primary Education, Vocational Selection, and Apprentice Training. The authors commence with a thoughtful analysis of the different types of industrial workers and their educational needs. In dealing with economic aspects they point out that, although the national expenditure on education cannot be regarded as excessive, much of the money spent is wasted, owing to the lack of proper supplementary training following primary education. Educational authorities and manufacturers need to get closer in touch and find common ground. In particular means should be taken to safeguard the future of educated youth and prevent the constant flow of boys into "blind alley" occupations, and more care should be exercised to determine the work for which each youth is best fitted. In the past British engineers have achieved much through inherent common sense and a kind of mechanical instinct, which almost amounts to a sixth sense. But in these days such natural advantages can no longer compete unless reinforced by scientific method and training.

A very interesting analysis is made of the system of training adopted in the schools at Gary (Indiana). Here the children are encouraged to take part in the practical work of the whole establishment—making furniture, attending to lighting motors, bells, farm work, &c., and special attention is given to vocational training.

The latter section of the book is devoted to a study of courses for apprentices, and an instructive survey is made of the methods of continuation school training in Munich—where only 8 per cent. of boys do not enter special trade schools. Stress is laid on the need for careful systematic consideration of the needs of local industries and the apportioning of the number of pupils trained to each trade. The authors also give an account of the system of instruction adopted in 1913 by the Westinghouse

Electric and Manufacturing Co. in this country which, we believe, has already had a marked influence on the success of this firm during recent years.

PETROL GAS FOR COUNTRY LABORATORY GAS SUPPLY.

A leaflet on this subject, issued by County Light, Ltd. (St. Stephen's House, Westminster), describes the well-known county system of petrol air gas lighting. It is remarked that people in country districts, where there is no gas or electric supply, would often find this method of lighting very advantageous.

For laboratories the system has a special utility, being applicable both for lighting and heating, and very suitable for local bunsen burners, and luminous flat flame burners, suitable for treating glass tubing, &c. We notice among recent installations that plants are used in the Government laboratories for H.M. Ministry of Munitions, the Royal Horticultural Society's laboratories at Wisley, in Surrey, and the Clinical Laboratory at Yelverton, in Devon.

It has often been pointed out as essential that a thoroughly reliable type of plant should be used in such cases, and we notice that County Light, Ltd. undertake a guarantee to replace free of charge any part that may require renewal for five years from date of installation.

Assets exceed
£2,500,000.



By Appointment.

Claims paid
over £8,500,000.

GENERAL

Accident Fire and Life

ASSURANCE CORPORATION, Ltd.

General Buildings, Perth, Scotland.

General Buildings, Aldwych, London.

Established 1886.

WAR ECONOMY.

In consequence of the War, the cost of building material and labour has increased nearly 50 per cent. All owners of property should therefore increase their Fire Insurances; this they can do at little or no extra cost by taking a **Fire Bonus Policy** with this Corporation, and thus effect a saving of 20 per cent. of each premium.

Particulars on receipt of post card at either of the above Offices.

F. NORIE-MILLER, J.P.
General Manager.

INDEX, June, 1916.

	PAGE
Editorial. By L. GASTER	183
Education, Science, and Industry. By PROF. R. A. GREGORY	197
Imperial College of Science, Visit of the Circle to	204
Sphere of the Scientific and Technical Press in Relation to Technical Education and Industrial Research, The. By A. P. M. FLEMING	187
<i>Discussion</i> —Prof. R. A. GREGORY—Mr. L. PENDRED—Dr. R. M. WALMSLEY—Mr. W. R. COOPER—Mr. GILBERT WOOD—Mr. J. S. DOW—Mr. L. GASTER (Chairman) Sir JOHN COCKBURN—Mr. GERALD LIGHTFOOT—The Rt. Hon. ARTHUR DYKE ACLAND—Mr. A. J. MUNDELLA—Dr. W. GARNETT—Mr. E. J. P. BENN	
189	
Topical and Industrial Section—	
Holophane Railway Station Lighting	205
Manufacture of Benjamin Reflectors and Fittings	206
Petrol Air Gas for Lighting Country Laboratories	208
Insurance Coupon	209
Concealed Church Lighting—A useful Lamp Guard	210
Reviews of Books—	
The Principles of Apprentices Training. By A. P. M. FLEMING and J. G. PEARCE	208

COUPON INSURANCE TICKET

Applicable only within the United Kingdom.

GENERAL ACCIDENT FIRE AND LIFE ASSURANCE CORPORATION, LTD.,

Chief Offices—

GENERAL BUILDINGS, PERTH, SCOTLAND.
GENERAL BUILDINGS, ALDWYCH, LONDON, W.C.
F. NORIE-MILLER, J.P., General Manager,

To whom Notice of Claims under the following conditions must be sent within
seven days of accident.

£250 TWO HUNDRED AND FIFTY POUNDS will be paid by the above Corporation to the legal personal representatives of any person who is killed by an accident causing material damage to the passenger train in which the deceased was travelling as a ticket bearing or paying passenger, or who shall have been fatally injured thereby, should death result within one calendar month after such accident. **Provided** that the person so killed or injured had upon his or her person, or had left at home this coupon, with his or her usual signature, written prior to the accident, in the space provided below, which, together with the giving of notice within seven days to the above Corporation is the essence of this contract.

This Insurance only applies to persons over 14 and under 65 years of age, is subject to the conditions stated above and contained in the General Accident Fire and Life Assurance Corporation Act, 1907, and holds good for the current month of issue only.

No person can recover under more than one Coupon Ticket in respect of the same risk.

Signature

This Coupon must not be cut out but left intact in THE ILLUMINATING ENGINEER as that, being dated, forms the only evidence of its currency.

CONCEALED LIGHTING IN A CHURCH.

We have received from the British Thomson Houston Co., Ltd., the following particulars of a novel and inexpensive lighting installation carried out by Messrs. Duncan Watson and Co., in co-operation with the B. T. H. Illuminating Eng. Dept., in St. Dunstan's Church, East Acton.



FIG. 1.—St. Dunstan's Church, East Acton. Showing arrangement of fittings where the arches spring from the pillar capitals.

Trough reflectors are concealed between the mouldings of the arches at the points where the latter spring from the pillar capitals. Three "Mirolux" extensive trough reflectors, each equipped with two 60-watt standard Mazda lamps are provided on the east pillars on both

sides of the nave, while the lighting of the chancel is served by a pair of similar reflectors, placed above the lower capitals of the pillars supporting the main arch. Light is thrown on the altar by single trough reflectors placed within the reveals of the two side windows.

A near view of several of these units is shown in Fig. 1, while Fig. 2 gives a good idea of the effect looking down the

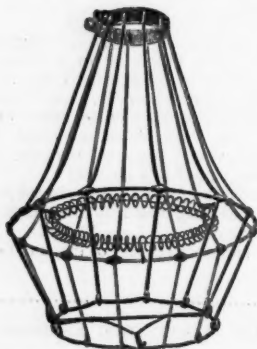


FIG. 2.—St. Dunstan's Church, East Acton. From an artificial light photograph. Note the entire absence of visible fittings.

church, the units being then out of view. The value of the illumination at the top of the pews is given as 2.5—3 foot-candles. Special units are also provided for lighting the vicar's stall and the Book on the lectern, and for the organ music.

A USEFUL LAMP GUARD.

A useful form of wire lamp guard is being supplied by the L. P. S. Electrical Co. (18, Adam Street, W.). The "Holdfast" Lamp Guard, as it is termed, is



"Holdfast" Lamp Guard.

well adapted to protect lamps from shock and vibration. The wire cage terminates in a clamping collar lock which forms a permanent and rigid guard to the socket, and there is also a ring of spiral wire which supports the lower part of the bulb, and helps in preventing breakage of lamps at the neck. The whole arrangement, besides protecting the lamp, serves to keep it completely removed from contact with any possibly inflammable material in the neighbourhood, and a special trap-lock prevents the unauthorised removal of the lamp.

Another useful product issued by the L. P. S. Electrical Co. is the flexible "Duraduct" woven conduit. This is made of non-metallic material, and consists of a single wall built up of an outer surface of woven cotton, an intermediate layer of hard twisted insulating paper, and a woven cotton interior surface. The material is claimed to be fireproof, non-hydroscopic, and of high insulating qualities.

